NEW AGE CONSTRAINTS ON THE SLATE ISLANDS IMPACT STRUCTURE, LAKE SUPERIOR, CANADA. V. L. Sharpton[1], P. Copeland[2], B. O. Dressler[1], and T. L. Spell[2], [1]Lunar and Planetary Institute, 3600 Bay Area Blouvard, Houston, TX 77058 (sharpton@lpi.jsc.nasa.gov),, [2]Department of Geosciences, University of Houston, 4800 Calhoun Road, Houston, TX 77204.

The ~7-km-wide Slate Islands group, located in northern Lake Superior represents the heavily eroded central portion of a complex impact crater [1-4] originally 30-32 km in diameter [1-3]. Macroscopic and microscopic evidence of shock metamorphism is characteristic of the Archean-to-Proterozoic igneous, metamorphic and sedimentary target complex. Field studies conducted in 1994 and 1995 revealed that the islands preserve not only the uplifted basement of the central structure, as previously recognized, but also vestiges of the allogenic breccia deposits along the inner flank of the original peripheral trough [3,4].

Previously available constraints on the formation age of this crater are weak (Table 1). Sage [5] presented K-Ar ages of 282±11 Ma for phlogopite and 310±18 Ma for antigorite of a lamprophyre dike that had been subjected to impact brecciation. Grieve et al. [6] suggested a maximum age of 350 Ma for the structure based on similarities between its erosion level and that of the Charlevoix structure in Quebec. Charlevoix has been isotopically dated at 357± 15 Ma [6,7]**.** However, erosion levels can vary considerably, especially in areas that have been subjected to glaciation. Furthermore, more recent U-Pb analyses of perovskite grains extracted from the same lamprophyre studied by Sage [5] yielded a Keweenawan age of 1.1 Ga (L. Heaman, University of Alberta, Edmonton: personal communication, 1994). Consequently, the Jacobsville sandstone (~800 Ma) appears to be the youngest target unit observed in the heterolithic breccias or otherwise deformed by the impact event [3,4]. Carbonate units probably were deposited throughout the region between the Michigan and Hudson Bay Lowland basins at some time between the Ordovician and Devonian [8] but these rocks have not been observed as clasts within the polymict breccias or in the parautochthonous target rocks [3,4]. These stratigraphic observations indicate an impact age no greater than 800 Ma and probably no younger than Early Silurian (~440 Ma).

TABLE 1: Stratigraphic Age Constraints on the Slate Islands Impact

Observation	Age Constraint	Comment	Reference
Brecciated Keweenawan rocks	<1.1 Ga		[5], this work
Brecciated Lamprophyre *K-Ar (antigorite)* *U-Pb (perovskite)*	 < 310 Ma < 1.1 Ga	 Crystallization ages; U-Pb more reliable.	 [5] L.Heaman, U. Alberta
Brecciated Jacobsville Formation sandstone	<800 Ma		[3,4]
Apparent absence of Phanerozoic rock fragments in breccias	>350 Ma	Michigan and Hudson Bay Lowlands basins were almost certainly connected sometime between Ordovician and Devonian [8].	[3,4]
Preservation state similar to 357 Ma Charlevoix structure	<350 Ma	Erosion highly variable; preservation state strongly affected by Recent glaciation.	[6]

^{40}Ar-^{39}Ar Age Determinations. In order to refine age constraints for the Slate Islands impact event, isotopic age determinations were made on five Slate Islands samples using the 40Ar-39Ar step-wise heating method at the University of Houston These samples included the following: *(i)* one sample of Keweenawan basalt (KB-1) representing the latest igneous unit involved in the impact event. *(ii)* one sample of clast-poor pseudotachylite (PT-1) from a narrow veinlet, *(iii)* one sample from a more clast-rich pseudotachylite veinlet (PT-2), and *(iv)* two samples of very fine-grained basaltic rocks (BR-1, BR-2) from massive outcrops containing clastic debris and no shatter cones. Field relationships and petrography indicated that these two basaltic samples could possibly represent target units remelted during the impact event.

Release spectra for samples PT-1 and BR-1 are shown in Figure 1. Both samples of basaltic rock, BR-1 and BR-2, suspected of possibly representing remelted basalts showed release patterns indicating formation ages between 1100 Ma and 1000 Ma. These ages are typical of Keweenawan basalts in the area (e.g. sample KB-1 yielded an age of 1090±5 Ma), thus indicating that these two samples were not remelted or reset during the impact event.

Both pseudotachylite samples yield spectra consistent with an impact age of ~450 Ma. The clast free sample PT-1 shows a relatively flat, plateau-like pattern across ~90% of its release spectrum with fluctuations between ~420 Ma and 470 Ma and an integrated age estimate of 440±3 Ma. In contrast, clast-laden sample PT-2 yielded a Keweenawan age (1240±30 Ma) but with evidence of a reheating event at ~450 Ma. Thus this sample probably represents clastic material only partly reset by the impact event, whereas PT-1 was more completely melted during impact.

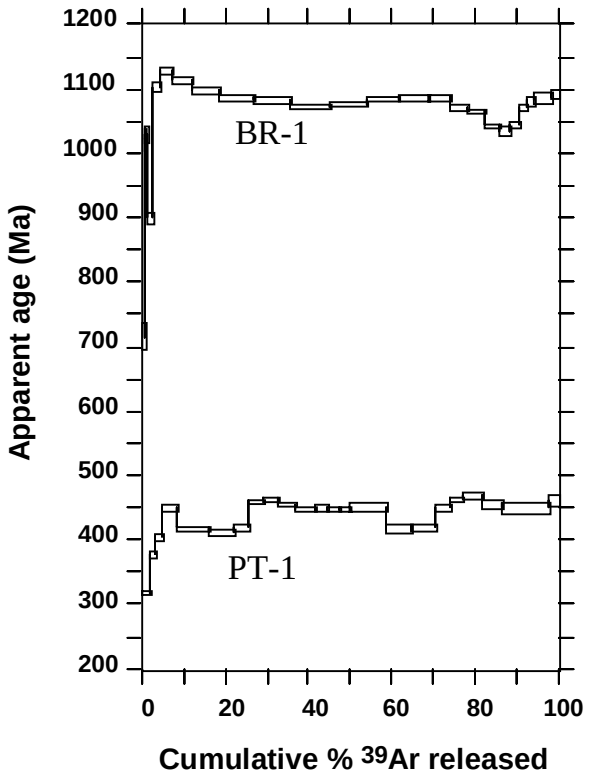

Figure 1. Age Spectra for Slate Islands samples

Because there is no evidence of volcanic or tectonic activity in the Great Lakes region more recent than the ~1100 Ma emplacement of the Keweenawan assemblage (Table 1), the pseudotachylites' ^{39}Ar-^{40}Ar release spectra most likely record the effects of the impact event itself. This yields a formation age for the Slate Islands crater of ~450 Ma and is compatible with the stratigraphic constraints listed in Table 1.

References: [1] Halls H.C. and Grieve R.A.F. (1976) *Canadian Journal of Earth Science 13*, 1301-1309. **[2]** Stesky, R.M. and Halls, H.C. (1983) *Canadian Journal of Earth Science 20*, 1-18. **[3]** Sharpton V.L., Dressler B.O., Herrick, R.R., Schnieders B. and Scott J. (1996) *Geology 24*, 851-854. **[4]** Dressler, B.O. and Sharpton, V.L. (1997), *Tectonophysics, in press*. **[5]** Sage R.P. (1991), *Ontario Geological Survey, Report. 264*, 111 p. **[6]** Grieve R., Rupert J., Smith J. and Therriault A. (1995) *GSA Today 5:10*, 189, 194-196. **[7]** Rondot, J. (1971) *Journal of Geophysical Research 76*, 5414-5423. **[8]** Norris A.W. and Sanford B.V. (1968) *Geological Survey of Canada, Paper 68-53*, 169-205.